Development Scenarios for Orange County, NC: Models to Guide the Comprehensive Plan Update

by

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Executive Summary

This report is intended to serve as a decision-support tool for Orange County, North Carolina as it updates its comprehensive plan. It attempts to help Orange County address critical growth concerns by providing descriptions, or scenarios, of possible future states. Two alternative scenarios are considered. The first—the Base Scenario—consists of existing plans and development regulations. The second—the Village Scenario—attempts to reconcile rural character and affordable housing concerns through a land use plan that substantially increases densities in areas suitable for more intense development and decreases densities in areas appropriate for conservation. Build-out analyses are then performed for both scenarios. The findings indicate that the Base Scenario can accommodate roughly 30,000 more dwelling units than the Village Scenario and that the Village Scenario preserves many more acres of land in areas designated for very low density development. While 30,000 dwelling units may appear substantial, this scenario accommodates many more dwelling units at build-out than would be possible under previous plans proposed for the county. Thus, in terms of preserving large tracts of rural areas while still accommodating a reasonable amount of growth, the Village Scenario appears to outperform the Base Scenario. This suggests that if communities can move past the politics of not-in-my-backyard and select reasonable locations for planned growth, then it is possible to balance these concerns that are often portrayed as mutually exclusive. The report concludes with a host of suggestions for further research that Orange County should consider pursuing, including commercial build-out analyses, consideration of the impacts of the upcoming Carolina North project on these results, and a study of the cost of service provision and demand for public services under the different scenarios.

I would like to thank the following individuals for their assistance with this project: Ray Burby, my advisor, for his guidance; Robert Davis of the Orange County Department of Planning and Inspections and Margaret Jones of the Environment and Resource Conservation Department for providing me with much needed data; and Brain Carson of the Orange County Planning and Inspections Department for providing me with data and always patiently answering my GIS and CommunityViz questions.

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Introduction

With limited resources in every sense of the word, concerns for equity, the economy, and the environment are often posited as at odds with one another. Orange County, North Carolina is no exception. Beginning with rapid population influx several decades ago, it continues to grow. Real estate prices are extremely high despite a slowed national market, and affordable housing is hard to come by. The county's unincorporated areas have a much more rural character than its municipal counterparts do, and residents consider this natural aesthetic a valuable resource. However, the county has experienced much political turmoil in recent years trying to determine how to simultaneously protect scenic and aesthetic resources while maintaining a land supply of a size adequate to not price residents out of the housing market. Planners in Orange County have now been grappling with this problem for well over a decade, if not longer.

Orange County residents, planners, and elected officials have just begun their update of the 1981 Comprehensive Plan, which originally consisted of just a Land Use Element. While several Elements—or chapters—have been added over the years since the 1981 plan's publication, this is their first opportunity for all of the Elements to be linked to one another. If stakeholders in the plan update process hope to reconcile the competing concerns described above, scenario planning may prove helpful in choosing an appropriate course of action to guide the county's future.

Scenario planning is an increasingly popular technique that provides a useful tool for analyzing land supply issues. It allows planners and citizens to think about the future by creating different approaches to growth management, observing how each approach results in different outcomes of interest, and then selecting the set of development policies most likely to realize their favored future. In planning for the future and anticipating consequences of growth management actions, land supply and capacity monitoring (LSCM) is a related, important task for governments, as they must know the amount of buildable land that exists within their jurisdictions, as well as the extent to which the land can accommodate future development. Failure to do so can result in common, yet calamitous problems, including a shortage of affordable housing, drastic reduction in open space, and provision of either too much or too little commercial space compared to market demand. Naturally, the amount of buildable land is contingent largely on a jurisdiction's development regulations. When communities make plans for the future that differ substantially from the present state, they will need to account for how these changes will affect the supply of and demand for land. In this way, land supply and capacity monitoring is an important component of scenario planning by which planners and community stakeholders can anticipate the consequences of policy alternatives on local land supply. Subsequently, they can plan accordingly and circumvent potential problems.

This report models two development scenarios for Orange County. Using its development regulations and environmental constraints, I evaluate how changes in certain inputs/assumptions alter both the amount of buildable land and how the county looks at build-out. The Base Scenario examines the continuation of current conditions, while the Village Scenario explores an alternative option that aims to address both affordable housing and environmental protection concerns. Understanding potential future development patterns can also assist in handling the ever-present local government concern of cost-effective service provision.

The goal of this project is to help Orange County address critical growth concerns by providing descriptions, or scenarios, of possible future states. It is my hope that these scenarios can guide the policy choices for the updated comprehensive plan and assist in elucidating the consequences of alternative policies for community members. With the results of these analyses, I do not suggest a specific course of action to follow. Rather, I simply evaluate the strengths and weaknesses of each scenario. Only through public participation can a desirable future for Orange County be determined (Meenar 2004). Thus, the focus of this report is on the development of decision-support tools for stakeholders.

Literature Review

Land Supply Monitoring – Importance

Land supply monitoring is critical for cities and counties to make effective policy decisions, as it is a means by which to obtain valuable land use information. Because land use problems exist everywhere, it is important for decision makers to have an accurate understanding of the extent and nature of these problems within their jurisdiction. Through land supply monitoring, one can develop a cadre of robust land use information to guide land use policies and regulations that ultimately lead to desirable outcomes (Lounsbury et al. 1981; Hubner and Moudon 2000; Aspinall 2000). The information obtained through land supply monitoring is also useful in *comparing* policy alternatives, as one might do in preparing a comprehensive plan. Hubner and Moudon (2000) argue that this information can be used to model policy alternatives and to estimate the effects of each alternative on future land use and development. In this way, its importance in the decision making process is not just on analyzing existing information, but also on using the information in a more forward-thinking manner. Finally, information obtained from land supply monitoring can also be used to evaluate and provide feedback on the effects of past decision making processes, such as the extent of implementation of past plans, or to make intervening adaptive management decisions (Huber and Moudon 2000; Aspinall 2000). Thus, land supply monitoring is vital for the entirety of planning intelligence.

Godschalk et al. (1986) and Berke et al. (2006) illustrate this point by demonstrating the effects of land use decisions on more specific subsets of the planning field. For example, without knowledge of land supply and demand, local governments risk unwittingly inflating both the price of land and the cost of public services. Consequently, they also risk encouraging undesirable development patterns. As the authors describe, when governments constrain the supply of buildable land through growth management or other regulatory measures, local housing prices may rise. Meanwhile, oversupply of land may encourage scattered development patterns that are not conducive to cost-effective provision of public services and facilities. By monitoring land supply, local officials can make informed policy decisions that positively influence community concerns such as affordable housing, access to open space, and tax rates. Communities can also better grasp demand for non-residential uses, thereby more appropriately allocating land for these purposes to promote economic development goals (Godschalk 2000).

Land Supply Monitoring – Techniques

As Hubner and Moudon (2000) note, there is is no absolute standard for how to monitor land supply or for its requisite data needs; most techniques are in-house creations driven by myriad priorities, ranging from growth management to watershed protection to economic revitalization. Nevertheless, there are some noted best practices in the field. Hubner and Moudon identify four primary tasks required of land supply monitoring and capacity building:

“1. Developing a comprehensive land supply database
2. Conducting an inventory of buildable land supply
3. Estimating development capacity
4. Applying land supply and capacity information to plan-making and plan implementation processes” (45).

For the development of a land supply database to serve as the backbone of land supply monitoring, they suggest the inclusion of the following information:

- “Existing and planned land uses
- Zoning and related regulatory overlays
- Other regulations that impose limits on density and use
- Census and other demographic data
- Data derived from remote sensing images
- Land ownership information
- Assessed valuation and taxation status
- Age of improvements
- Environmental conditions and natural features, including shorelines, rivers and streams, topography, wetlands, steep slopes, soils, and natural areas
- Existing and planned infrastructure
- Development in the pipeline, particularly as derived from permits
- Market-related data” (46).

Once these data have been assembled, it becomes possible to assess the amount of buildable land within the jurisdiction. Again, techniques for the analysis vary by jurisdiction, but a core of practices for such an undertaking that may be defined as best practices does exist. Hubner and Moudon (2000) differentiate between “land supply” and “land capacity.” While the former refers to the entire land base within the jurisdiction, the latter refers to the nature and extent of development and activities that may occur on the land, resting on local regulations and market conditions. They then distinguish between buildable land supply—to be expressed as the amount of land on which new or additional development can occur given market and regulatory constraints—and development capacity, which describes the amount of development—expressed as a quantity of built space—that can occur on the estimated buildable land.

Hubner and Moudon (2000) and Berke et al. (2006) delineate different types of measures of buildable land supply and development capacity. Maximum supply reflects the numbers derived by communities when they perform a build-out analysis, as it represents the amount of land that can be developed and the amount of development that can occur given existing land use regulations and environmental and infrastructure constraints. This differs from adjusted supply, which is more nuanced in its consideration of what is likely to be built and how it is likely to be built (including consideration of the possibility for under-building). Thus, it considers market and political conditions, as well as local cultural preferences.

In calculating development capacity, Moudon and Hubner (2000) describe reasons why an agency performing a build-out analysis may or may not assume full build-out. Some agencies apply an under-build factor to reflect observed development trends. Even when under-building is possible, some jurisdictions may still assume full build-out if their reason for undertaking the analysis is to estimate the greatest extent of environmental impacts. Communities in which demand for residential land appears so high that substantial under-building is unlikely will also want to model complete build-out.

Burchell (2000) and Moudon and Hubner (2000) suggest the development of physical and environmental constraint layers in a GIS to assist in assessing the amount of buildable land within a jurisdiction. These include steep slopes, floodplains and other hazardous areas, soils not suitable for development, wetlands, riparian corridors, and water resources. Moudon and Hubner add to the constraint layers by advocating for the inclusion of regulatory constraints, infrastructure constraints, and a "market factor" from which percentages may be deducted from the estimated yield.

Land Supply Monitoring – Problems with Accuracy

As with anything assembled by the human hand (or assembled by a machine created by the human hand), accuracy remains a problem in land supply monitoring. When it comes to the spatial data required of this task, Aronoff (1989) describes accuracy as taking seven forms: positional, attribute, logical consistency, resolution, completeness, time, and lineage. Error arises throughout the process of maintaining a land information system, including from data collection, data storage, data manipulation, data output, and use of results. Aspinall (2000) assesses these problems in terms of three types of uncertainty; stochastic uncertainty is that which is inherent to land use systems, structural uncertainty reflects our inability to specify and model systems, and partial uncontrollability reflects our limited amount of system control. He argues that they emphasize the importance of monitoring and adaptive management techniques.

Specific to performing a build-out analysis, Hubner and Moudon (2000) note that most of such analyses focus on vacant land, thus failing to consider the opportunities for redeveloped parcels to be added to the buildable land supply. Naturally, this is a result of lack of data to make such estimates. Yet, it results in inaccuracies nevertheless. Similarly, they note the difficulties in estimating the extent to which there will be underbuilding—often the result of a lack of linkages between physical and market data—that often results in overestimates of the amount of development that will exist at build-out.

The authors develop a list of issues that they believe ought to be considered in land supply and capacity monitoring, specifically as it applies to plan-making and other decision making processes based on land use information. Their list includes such inescapable problems as the need to monitor the vast amount of development in the pipeline, the ability to translate complex long-range planning concepts into appropriate units and scales that can be monitored and analyzed, and the problem with trying to designate population growth into individual, small land use areas within a region.

Scenario Planning – Theory

The concept of envisioning a desirable future is at the heart of the planning profession, and yet it is one that some have argued has disappeared from practice (Wachs 2001; Couclelis 2005). While the paradigm shift in planning from a design focus to an analytical focus is widely construed as positive, there is concern that many present-day plans are simply responses to forecasts without any effort to visualize an ideal community and then work towards its realization (Wachs 2001). Scenario planning is a technique emerging from the modeling/technocratic world that could better merge these two approaches through its analytic component and amenability to public participation and community visioning.

In the context of applying business world scenario-building methods to comprehensive planning processes, Avin (2000, 3) uses van der Heijden's definition of scenarios as "a set of reasonably plausible, but structurally different futures." Other definitions of a scenario range from a "description of a future situation and the course of events which allows one to move forward from the original situation to the future" to the simpler, "backdrop for policy analysis" (Couclelis 2005, 1363). Still others insist on putting more emphasis on their hypothetical nature. Indeed, it is worth stressing that they are not forecasts and are much more normative nature (Couclelis 2005).

The increasing popularity of scenario planning is largely tied to its purported ability to enhance decision-making processes and public comprehension of complex planning concepts (Verburg 2004). While traditional land use models are important tools, they have value beyond that for which they're customarily used (Couclelis 1368). The visioning component of scenarios is one example of this. Another example is their visualization component, which can serve as a common language understandable to both planners and the public. In this way, scenario planning can serve not just to increase public participation—and consequently a project's credibility—but also comprehension for all stakeholder groups that can lead to higher-quality decisions (Al-Kodmany, 2002; Appleton and Lovett, 2005; Aspinall 2000; O'Looney 2000; Berke et. al. 2006; Steinitz 2003).

Lastly, scenario planning is increasingly used for its ability to compare alternative courses of action (Aspinall 2000). Community members can then evaluate the merits and faults of a certain course of action compared to one another, an increasingly rare and important concept in a public realm that must cope with complex issues and limited resources (Steinitz 2003). Hubner and Moudon (2000) describe how after establishing baseline data from a land capacity analysis, one can apply the findings by testing various scenarios to assess the performance of proposed plans and regulations against potential future conditions.

Scenario Planning – Techniques for Comprehensive Planning

To determine regional issues of concern that the scenarios developed ought to address, questionnaires can be developed based on issues under discussion in public meetings and local media and then given to public meeting attendees or posted on a website (Steinitz 2003). Regarding scenario planning for comprehensive planning processes, Avin determined that understanding the nature and magnitude of possible futures is their primary benefit, and that a limited number of alternative scenarios is ideal, as the process can otherwise take a detrimentally-long period of time to complete. In addition, the planners and consultants with whom he spoke recommended building scenarios that differ strongly from one another. Berke et al. (2006, 268) say they are of most use for "situations where significant change is likely, outcomes are not obvious, and the timeframe is medium to long term.

Avin (2000) and Landis (2001) describe two methodological approaches for scenario building. Based in the traditional planning-as-design concept, the incremental approach imagines a desirable future state and then works backwards to identify how assumptions can be adjusted to reach that outcome. Avin recommends this approach in situations in which certain stakeholders are committed to one official future. Contrastingly, the deductive approach, which comes out of the newer planning-as-analysis framework, sets different present-day policies and traces their effects forward into the future.

In addition, many scenario planning situations make use of one or many build-out analyses, allowing the community to see what it could look like if it were to grow to its boundaries (Meenar 2004).

Scenario Planning – In Planning Practice

Specifically in the context of comprehensive planning, Berke et al. (2006) explain how scenarios can be useful to the process, as they can be derived and evaluated by varying a host of development assumptions. To evaluate where growth might go and how it would affect the local ecosystem, Landis (2001) developed three scenarios for Santa Cruz County, California, including no constraints (other than prohibiting development on wetlands), farmland protection, and environmental protection. The resulting development pattern varied between scenarios due to their respective differences in means of administering regulations. Portland, Oregon's regional planning body, Metro, had a similar idea in mind when they began their Region 2040 project, initiating the process with the creation of a base scenario that demonstrated a possible future if no changes were made to existing development patterns and processes. Metro's staff then used this information, coupled with community values, to generate three alternative urban form scenarios that they used in the discussion and construction of a final, preferred alternative (Seltzer 2004). August County, Virginia used a similar process for updating their comprehensive plan by developing several "Future Conditions Scenarios," one of which ultimately proved a favorite with the public and steering committee, and in turn guided the plan update (Augusta County 2007).

In 1993, researchers at Harvard University partnered with the Environmental Protection Agency to study scenic and fast-growing Monroe County, Pennsylvania. Their team devised six alternative futures for the county to guide them to the year 2020. These included following the county's comprehensive plan, development driven by the market, a township-driven (rather than regional) approach, and two conservation-based approaches. Their findings were later used in the county's conservation and development plan, as well as to support the passage of a twenty-five million dollar bond for conservation purposes (Steinitz 2003; Steinitz et al. 1994).

To compare impacts on public service costs, energy costs, walkability, vehicle miles traveled, and other variables, the City of St. George, Utah modeled two scenarios—one for their existing growth plan and one that embraced more progressive planning concepts. They then compared the scenarios using the CommunityViz software program and selected a course of action to guide them in coping with anticipated growth pressure (Federal Highway Administration 2007).

Exclusively using build-out analyses to allow the community to see what it could look like should it develop all of its buildable land, Meenar (2004) developed four growth scenarios for Milford Township, PA, including unconstrained, very constrained, and two higher density development scenarios. This allowed him to evaluate how many buildings could be constructed under different regulations, as well as their placement on the landscape given constraints. From this, he was able to extrapolate projected population increases (using existing population figures), as well as potential increased use of services like water and sewer. He mentions that if he had more time to complete the project, the versatility of the CommunityViz software program also would have allowed him to do useful calculations, such as,

> "1) Compare fiscal implications between Alternative scenario 1 and 2
> 2) Compare estimated changes in total land consumption and total preserved land between Alternative scenario 1 and 2 . . .
> 3) Develop goals, implementation policies, and indicators to assess progress" (16).

Finally, Couclelis (2005) further argues that through their scientifically grounded and visualization-based techniques, when brought into a community, scenario planning has the unique potential to help overcome divisiveness within a community.

Conceptual Framework

Figure 1 below illustrates the assumptions behind the model used for analysis in this report. It is assumed that two broad categories of factors influence the amount, type, and location of development within a given jurisdiction. The development regulations portion of the flow chart represents the items that the community can—at least in theory—control. Development regulations included in this analysis are primarily the zoning code and subdivision regulations. While not legally binding, for the purposes of this analysis, the Comprehensive Plan and relevant small area plans are also included.

Regulations, along with forces beyond the community and local government's control, result in the community's development pattern. Such forces include building practices, real estate market conditions, and population trends. Although they are unable to control these phenomena, they can mitigate their effects by anticipating them through the use of forecasts, land supply and capacity monitoring, and sufficient inventory of other pertinent community conditions.

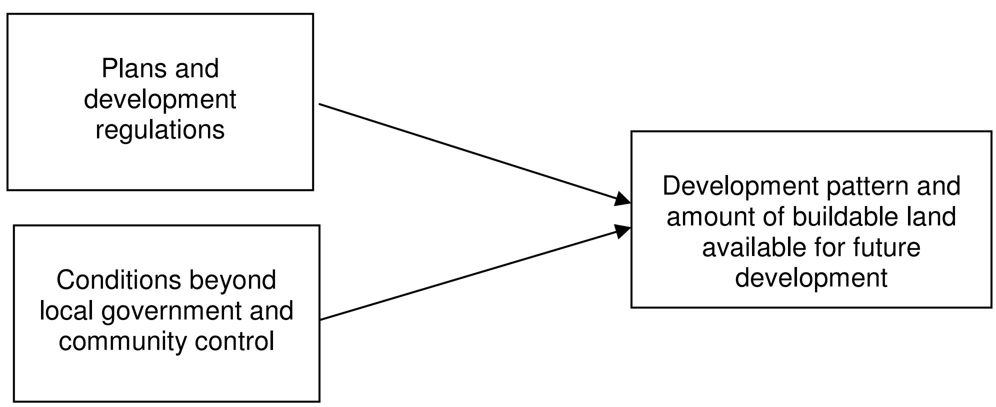

Figure 1: Conceptual Model for Analysis

Methods

This study assessed the amount of buildable land and development capacity in Orange County given environmental and regulatory constraints ("Base Scenario"). This same analysis was then undertaken assuming an alternative land use pattern ("Village Scenario").

All of the spatial data were procured from the GIS Division of the Orange County Planning and Inspections Department. These include data layers for parcels, buildings, addresses, floodplains and floodways, streams, watershed boundaries, wetlands, wastewater service boundaries, municipal jurisdiction boundaries, soils, roads, and wildlife corridors. Spatial data for protected lands were obtained from the Orange County Environment and Resource Conservation Department. Appendix A contains a map of land in Orange County under the county's jurisdiction, while Appendices B and C show wastewater service boundaries.

From these data and a county soils survey, I created a data layer of land unsuitable for development (identified by the soil survey as having severe slopes). This serves as a proxy for Orange County's provision that prohibits development on slopes of 25% or greater.

All information on zoning districts came from the Orange County Zoning Ordinance. In addition, to better understand the development process, on February 19, 2007, I spoke with Robert Davis, Current Planning Supervisor. Refer to the Base Scenario build-out report in Appendix F for detailed information on regulations in each zone.

Orange County does not have a point file of existing dwelling units. However, it does have a polygon layer of existing buildings that includes building geometry, as well as a point file of existing addresses that is used by county Emergency Management Services. Because the existing building layer contains innumerable features that are not dwelling units (such as sheds, garages, and other storage facilities), I simulated an addressed, commercial and residential layer with building geometry by spatially joining the two layers. This consisted of attaching all addresses to the nearest building polygon, thereby eliminating all buildings without addresses. Naturally, the accuracy of this method remains limited; because some addresses may not be correctly georeferenced, the nearest building may actually not be a residence. Nevertheless, it was the best available proxy.

Figures 2 and 3 contain the land use allocation map for the Village Scenario, which was created to balance local concerns about affordable housing and preservation of rural character. These concerns are reflected in newspaper articles, some of the reasons the Board of County Commissioners rejected the 2006 update to the comprehensive plan's Land Use Element that substantially downzoned most of the land under the county's jurisdiction, and the rural character studies that have been conducted. In developing the Village Scenario, I was guided primarily by two County documents: the

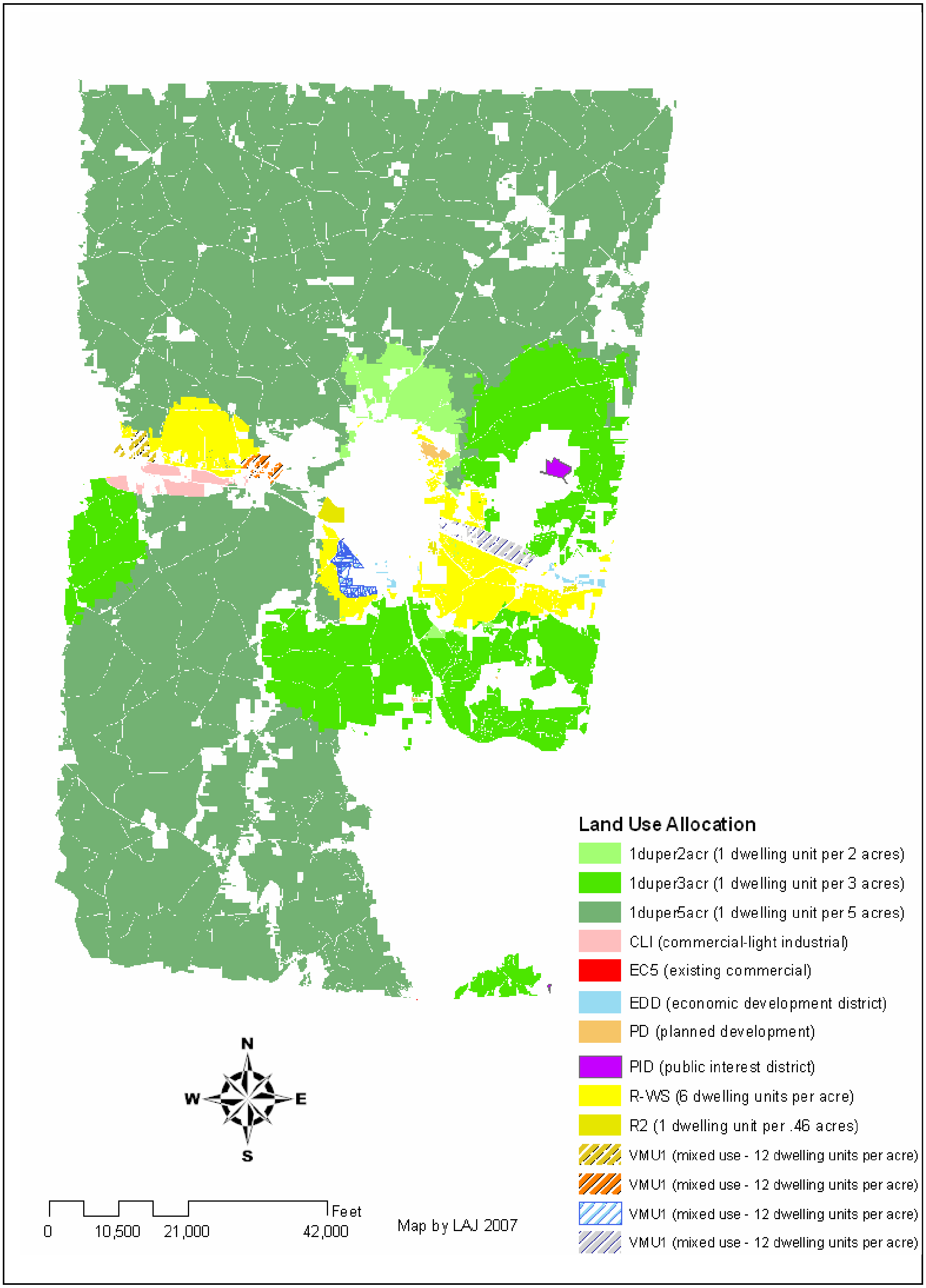

Figure 2: Village Scenario Land Use Allocation Map – general

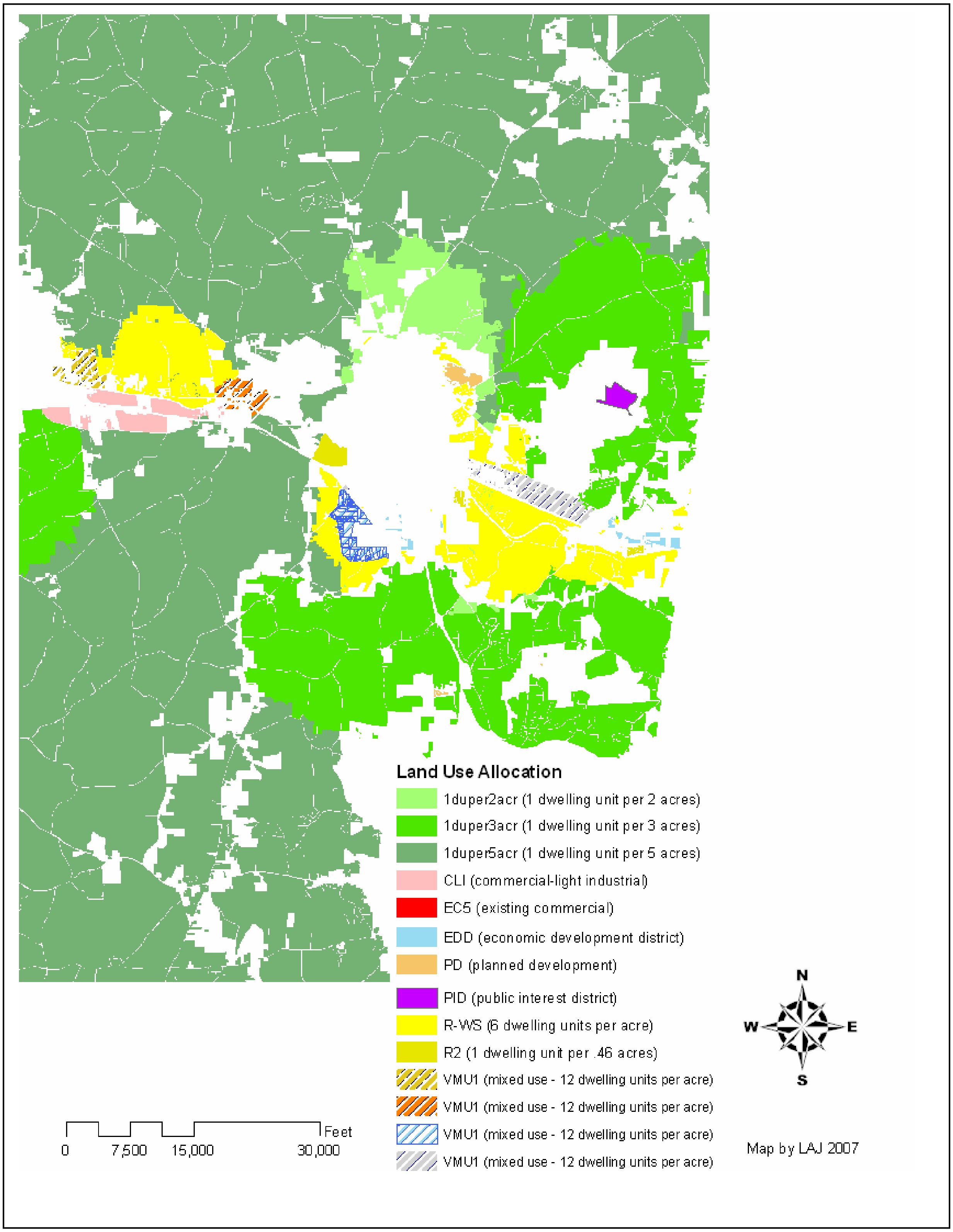

Figure 3: Village Scenario Land Use Allocation Map – detailed

Efland-Mebane Small Area Plan and the draft Land Use Element of the Orange County Comprehensive Plan as proposed in 2006. I first took land zoned or planned as economic development districts and rezoned it as a mixed use village. These areas include the Buckhorn Road EDD, the Hillsborough EDD, and the Durham/57 Speedway EDD. I also applied this process to part of the Efland Transition Area along U.S. 70, as this area is to be served by water and sewer in the future and the Efland-Mebane Small Area Plan identifies the corridor as appropriate for a balance of commercial and residential uses. I estimated the density of the mixed use villages at twelve dwelling units per acre, as the Efland-Mebane Small Area Plan states that the U.S. 70 corridor is to have a density no lower than six dwelling units per acre. These four areas are listed on the zoning map as VMU1, VMU2, VMU3, and VMU4. Also per the Efland-Mebane Small Area Plan, I reserved some of the area along Interstate 40/85 for commercial and light industrial uses. They are listed under the designation "CLI" on the map. However, as commercial areas, they were not included in the build-out analyses.

I then identified all parcels within the OWASA primary service area that are currently designated as AR, RB, and R1 and changed their densities to six dwelling units per acre. Because these areas are expected to be on public water and sewer within the next twenty years (if they are not already), they are clearly appropriate for higher density development. These areas as listed as "R-WS" on the land use allocation map.

Finally, I allocated the remaining land according to the designations suggested in the Draft Land Use Element from 2006, which was not adopted by the Board of County Commissioners due to affordable housing concerns, among others. In its appendices, this draft plan proposed four residential density options based on watershed boundaries and with the primary goal of water supply protection (in addition to rural character preservation). Each option has decreasing population growth potential. My land use allocations for these remaining parcels are based on their "Option 2 – Low Density/Low Vehicle Miles Traveled (VMT) Plan," with densities ranging from one dwelling unit per two acres to one dwelling unit per five acres depending on the watershed in which the land is located. These areas are listed as 1duper2acr, 1 duper3acr, and 1duper5acr on the map. Refer to Appendix D for a map of the proposed land use allocations.

All spatial data were imported into ArcMap (ArcGIS 9.1) and residential build-out analyses were conducted using the Scenario360 module in the CommunityViz program. Efficiency—which accounts for density losses due to infrastructure and other building requirements—was assumed to be 90% for all districts as based on a conversation with Robert Davis, supervisor of the Current Planning Division in the Orange County Planning and Inspections Department. The build-out analyses used the following data layers as constraints to development, which were identified from zoning and subdivision regulations:

- roads
- wetlands
- 65' stream buffers (stream buffers for development are always either 65' or 80', depending on percent slope. Because this is impossible to simulate

given data availablity and time constraints, I chose the smaller buffer. Thus, readers should keep in mind that this may overestimate the amount of buildable land).

- permanently protected land
- slopes greater than 25%
- land within the floodplain
- land within the wildlife corridor (considered “natural areas”)

Refer to Appendix E for a map of development constraints.

Orange County’s subdivision regulations require that most subdivisions leave 33% of the land as open space. They have separated the land to be included in this amount into “primary open space” and “secondary open space.” The constraints above represent those that fall in the “primary open space” category. Because Robert Davis indicated in our conversation that most of the open space requirement is satistified with land from this first category, I used only these constraints to simulate the amount of developable land.

Although I identified soils with limitations for septic tank use—a major concern in a jurisdiction in which most units are not and are not ultimately anticipated to be connected to the public sewer system—it was not included in this analysis. Despite being costly, engineering innovations have proven able to overcome this limitation. In an area such as Orange County in which land and residences are in high demand, engineering expenses were assumed to be easily recouped and thus not a constraint to development. Soils with building limitations other than severe slopes (not buildable by development regulations) were not included for the same reason.

The build-out analyses were performed in two stages. The first, numeric build-out analysis, estimates the number of buildings, by use, which could be built under the given constraints. The second, spatial build-out analysis, places the new buildings on parcels and refines the numeric analysis to account for building limitations that are not due to regulations, but rather to parcel geometry.

To determine the population size that will be accommodated by the amount of residential development estimated by the analyses, the number of dwelling units was multiplied by average household size in Orange County (2.19 people per household) as reported in the U.S. Census’ 2005 American Community Survey.

Findings

Base Scenario

Figures 4 on the following page shows the amount of buildable land by zoning designation in Orange County. Full results for the Base Scenario build-out analysis can be found in the report in Appendix F, while Table 1 below summarizes some of the more important results.

Table 1: Base Scenario Residential Build-out Analysis Results

Land Use Designation	Number of New Residences	Residential Net Buildable Area (acres)
AR	78,958	90,981
RB	5,584	19,809
R1	11,277	15,991
R2	31	91
R4	8	14
Total	95,858	126,888

Roughly 70% of Orange County's gross land area is suitable for development. The amount of residential buildable land represents 99.5% of total buildable land within the county's jurisdiction, most of which is in the AR zone. Only a very small amount of higher density development (R2 and R4) can be accommodated under current land use regulations, with buildable area under these designations accounting for just .08% of total residential buildable land.

Assuming that housing trends remain constant in Orange County, these 95,858 new residences will result in an additional population of 209,929 individuals (U.S. Census Bureau). Combined with the current population, the county could have a population of 254,758 residents in its unincorporated areas (North Carolina State Demographics 2006). The 2005 population in these areas was 44,829 (North Carolina State Demographics 2006).

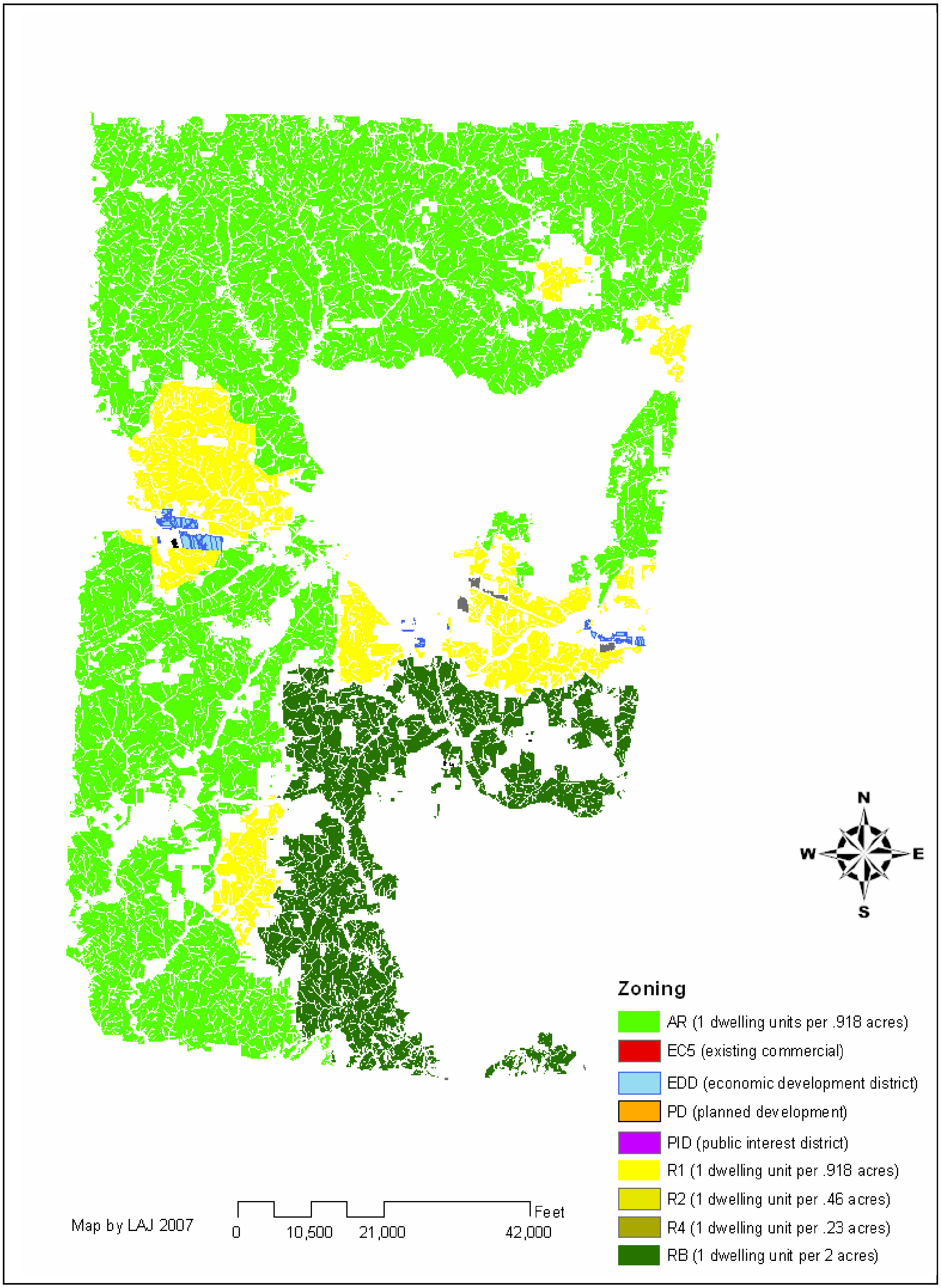

Figure 4: Base Scenario - Buildable Land Supply by Zoning Designation

Village Scenario

Figures 5 on the following page shows buildable land supply by land use designation under the Village Scenario. Complete results for this analysis can be found in Appendix G. Table 2 below presents some of the most important results from the report.

Table 2: Village Scenario Residential Build-out Analysis Results

	Number of New Residences	Residential Net Buildable Area (acres)
1DUP2	49	162
1DUP3	3,349	17,828
1DUP5	12,513	100,746
R2	147	139
R-WS	31,541	6,262
VM1	2,470	258
VM2	2,648	260
VM3	4,949	472
VM4	5,303	528
Total	62,969	126,654

The amount of residential buildable land represents 99.28% of total buildable land within the county's jurisdiction. Higher density residential land use designations (R2, R-WS, VMU1, VMU2, VMU3, VMU4) can accommodate 6.25% of total new residential development. Most of the buildable land is located in the 1duper5acr and 1duper3acr districts, but the relatively high density R-WS district contains the third largest amount of buildable land and will account for nearly half of the new dwelling units.

Assuming that housing trends remain constant in Orange County, 62,969 new residences will result in an additional population of 137,902 individuals (U.S. Census Bureau). Combined with the county's current population, the county could have a population of 182, 731 residents in its unincorporated areas (North Carolina State Demographics 2006).

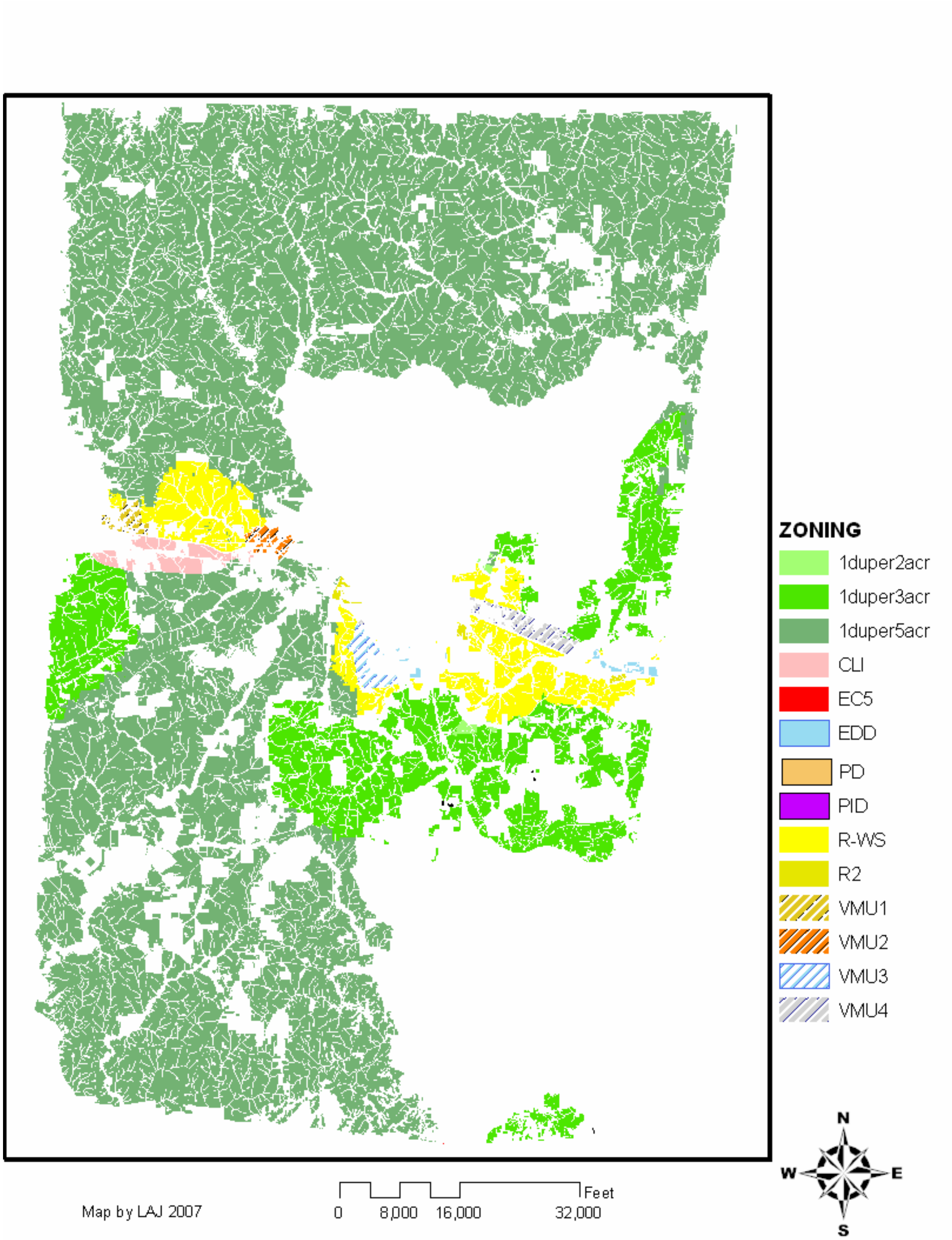

Figure 5: Village Scenario - Buildable Land Supply by Land Use Designation

Figures 6 and 7 compare new residential units and total build-out population, respectively, under each scenario. The charts show that the Base Scenario allows for an additional 32,889 new dwelling units compared to the Village scenario and a total build-out population of 72,027 more people. Depending on the perspective of housing advocates, this loss of nearly 33,000 dwelling units may appear substantial. On the other hand, it may not seem like a particularly large amount given the large number of housing units that would have been lost with the approval of earlier plans for downzoning.

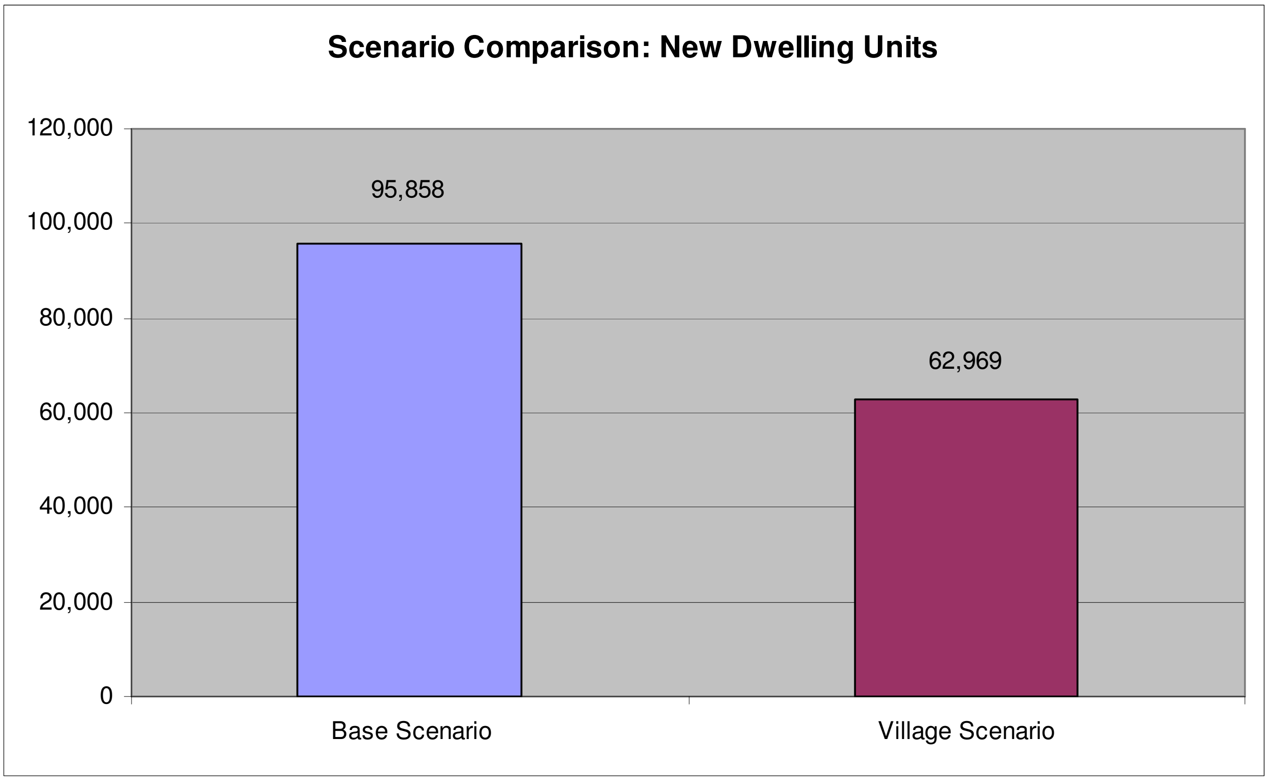

Figure 6: Scenario Comparison of Additional Dwelling Units

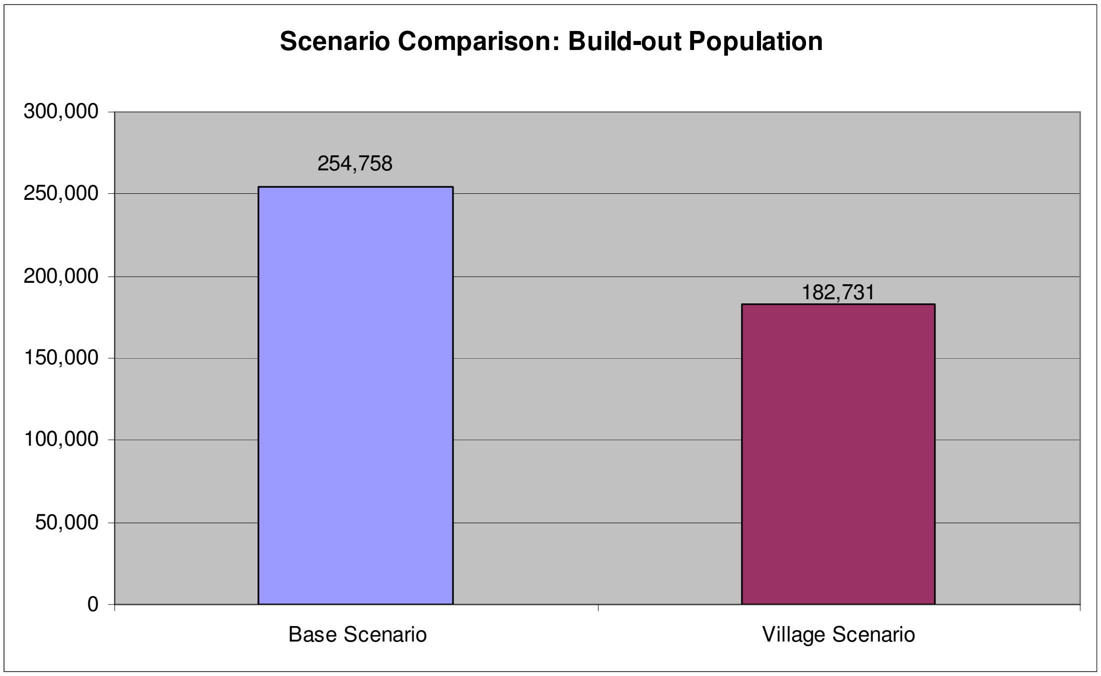

Figure 7: Scenario Comparison of Population at Build-Out

Figure 8 on the following page indicates that the amount of buildable land for residential uses is roughly the same under each scenario. However, the amount of land available for extremely low density development in the most rural parts of the county differs substantially between the two scenarios. At one dwelling unit per 2 acres, the rural buffer (RB) zone is the least dense in the Base scenario. At build-out, 30% of the land in this district will prove not buildable or will otherwise be left for open space, accounting for 8,453 acres. Within the Village Scenario, there are three areas with very low densities: 1duper2acr, 1duper3acr, and 1duper5acr. At build-out, these areas will be 95%, 39%, and 27% open space, respectively, totaling 52,179 acres. Thus, in terms of preserving large tracts of rural areas while still accommodating a reasonable amount of growth, the Village Scenario appears to outperform the Base Scenario.

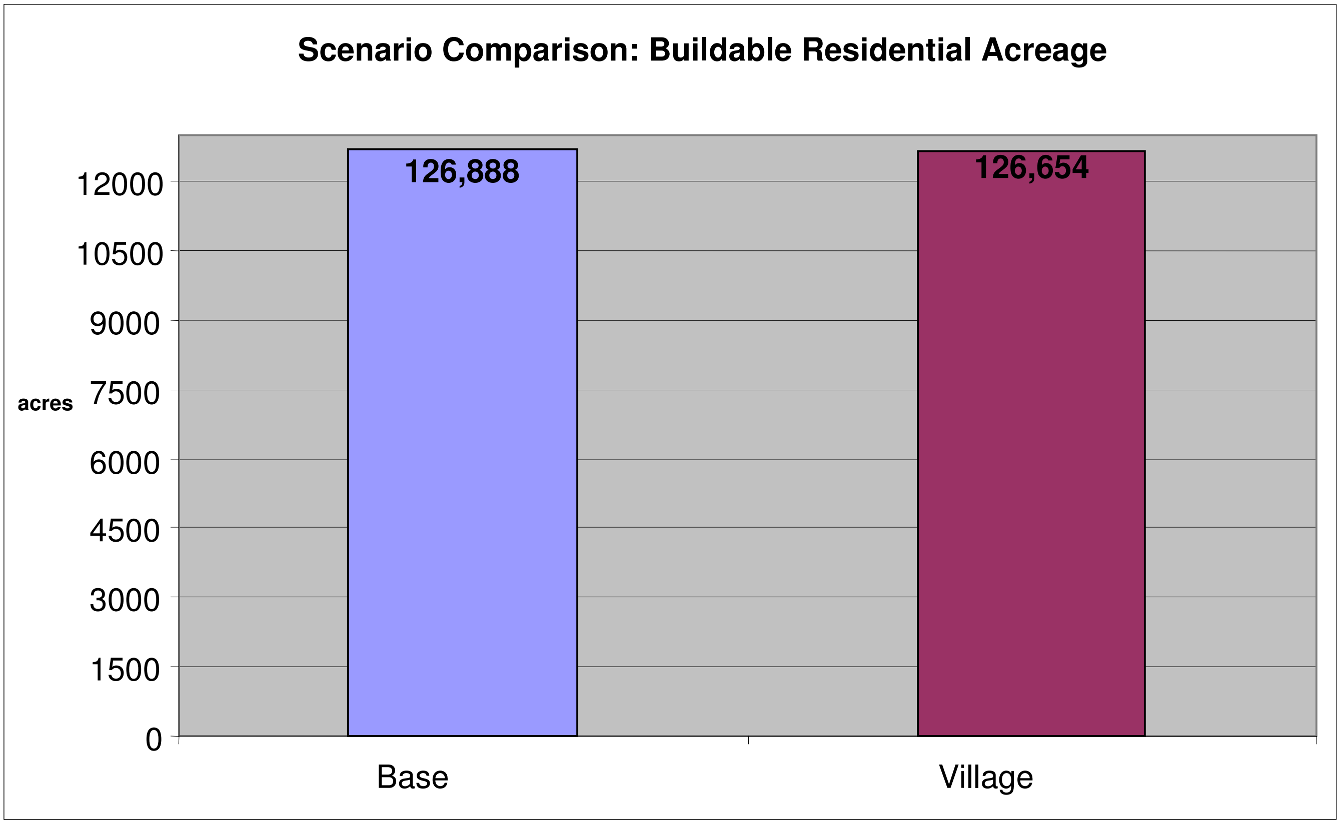

Figure 8: Scenario Comparison of Buildable Residential Acreage

Implications and Conclusions

Policy Implications and Importance of Findings

The results indicate that affordable housing and rural character/environmental concerns don't necessarily need to compete with one another. While the Base Scenario proved capable of accommodating roughly 33,000 more new dwelling units than the Village Scenario, the Village Scenario is a vast improvement over the many more units that would have been lost given the proposed downzoning in most areas of Orange County or the many undeveloped and aesthetically valuable acres that would be lost if growth occurs in all zones. The results show that choosing where *not* to grow must be accompanied by a decision about where to grow. In areas such as Orange County where moderate population growth is anticipated, failure to select strategic locations for growth will have unpleasant social and environmental impacts. However, if communities can move past the politics of NIMBYism and select reasonable locations for planned growth, then it is possible to balance these concerns that are often portrayed as mutually exclusive.

With this in mind, Orange County planners can use these results to guide their Comprehensive Plan update and, in particular, the Land Use Element. With this build-out analysis, they can gain a better understanding of the amount and locations of developable land under their jurisdiction and, from there, design a land use plan that helps the land supply to best meet the host of demands imposed upon it. The visual resources that accompany the report may prove useful for public participation events, allowing stakeholders to use the charts, maps, and tables to better understand the implications of different land use planning decisions and the future consequences of different sets of regulations. I also hope it might be of assistance to the Board of County Commissioners should they adopt the proposed transfer of development rights program. If the program is adopted and does not include a mechanism for transferring rights to the incorporated areas of the county, then it could be particularly helpful for them in determining the areas in which development rights could be bought for higher density development and the areas in which rights could be sold for preservation or agricultural purposes. The results of this report should help them understand the consequences of targeting specific areas in the county for development as opposed to preservation, and vice versa.

Having developed this project with the intention of creating a decision-support tool, I hope that this report can mitigate some of the tensions surrounding planning for growth. It should be clear from these findings that, with a commitment to strategic growth management planning, the needs of housing advocates and environmentalists can both be reasonably met. Some give-and-take, however, must come from both sides. Environmentalists need to accept that in order to preserve the more ecologically and aesthetically important resources in the county, they will have to allow for increased growth and densities in less sensitive areas. With anticipated population growth, this is inevitable if Orange County is to save *any* of its rural character. Past attempts to create land use plans that downzone most of the county for reasons of environmental protection have been successfully thwarted by those concerned about housing affordability. This report shows that certain areas *can* be downzoned to densities as low 1 dwelling unit per 5 acres if environmentalists agree to higher density development in areas appropriate for such development, such as those to be served by public water and sewer and those with historically higher residential densities.

Affordable housing advocates, meanwhile, must agree to work with environmentalists and concede that certain areas are more appropriate for higher density development than are others. In a place such as Orange County in which the housing market remains strong despite national trends, housing advocates have no choice but to cooperate with other stakeholder groups in order to see that their ultimate priority—the availability of increased housing opportunities for low and moderate-income individuals—is met.

Finally, I believe that the build-out analyses alone are a valuable resource for Orange County planners, as they are substantially more sophisticated than similar past endeavors. Build-out analyses of proposed lower density alternatives that accompanied a 2005-2006 effort to update the Land Use Element of the Comprehensive Plan contained a numeric build-out analysis that included primarily regulatory and legal constraints to development, such as conservation easements and natural areas. By not considering limitations from existing development, infrastructure limitations, efficiency losses, and losses from parcel geometry (assessed during this project's spatial build-out component), their study may have overestimated the amount of development that could have occurred with each scenario, thereby unwittingly further constraining housing supply via a course of action that inherently constrains the supply through downzoning plans.

Limitations of the Study

As with any body of research conducted over a relatively short period of time, this project has some noticeable limitations. In a few instances, due to data availability in particular, proxies were used to simulate conditions for which a more realistic model was infeasible. For example, the number of projected dwelling units for each scenario may be somewhat inaccurate because I had to create a means for including this information in the analysis in the absence of such spatial data. To create a proxy, I joined building polygons (which includes everything ranging from houses to sheds) with the nearest address point and created a new layer to represent existing dwelling units. In the event that address points were incorrectly georeferenced and the nearest building proved to be a shed, incorrect spatial dimensions were used in the analysis. Similarly, because the streets are line files and consequently lack width, I had to use a proxy by buffering 10 feet on each side to create a twenty foot road buffer. Thus, depending on the actual width of the road, more or less land may be available for development. This same problems exists with having to choose the smaller of the two stream buffer possibilities for modeling purposes and thus possibly overestimating the amount of developable land. Nevertheless, perfect modeling is never possible given the constraints of time, data accuracy, and future uncertainty.

Despite the fact that I prepared these data, I chose not to include in the analysis such limitations as highly erodable soils, soils that pose limitations for septic tanks, and soils that pose limitations for building purposes (note: slopes greater than 25% were included in the analysis, as Orange County does not allow building on such inclines). Instead, I assumed that these conditions were only constraints if demand for land and housing in Orange County were low. Rather, because it is high, I supposed that this demand would cover the cost of engineering mechanisms to circumvent these conditions. Nevertheless, only the market will tell over time if these engineering assumptions are, in fact, feasible. Should they prove otherwise, the amount of developable land in Orange County may have been overestimated by this study.

The model also does not consider commercial build-out and the impact that this would have on residential build-out. Similarly, there was no means for it to consider the impact of Carolina North on residential build-out in the unincorporated portions of Orange County. While this project is supposed to include some on-site housing, the extent of it will be small compared to the number of jobs created in the area. Employment migrants will need a place to live, and with a tight market and not much developable land, the areas of Orange County outside of Chapel Hill town limits are an obvious choice. This is particularly true given the site's location in the town's northern area (as opposed to say, southern area, where in-migrants might consider living in Chatham County). Given this anticipated increase in demand, the 30,000 dwelling units of the Village Scenario might be particularly troublesome to affordable housing advocates. However, there was simply no way to account for this project that is still in the conceptual phase but indisputably looms in the pipeline.

Finally, like all models, this one will always be limited by its assumption of continuance of trends, such as those described above regarding market conditions and costs of engineering mechanisms in construction. By not having a predictive component, it escapes many of the pitfalls of models that project certain events to occur by a given point in time. Nevertheless, it assumed that building practices will continue to occur in a manner like they do today; that there is a market for higher density and mixed use developments in Orange County; that the County's Lands Legacy preservation program will be somewhat limited in impact or that there will be limited future acquisition of conservation easements; and that OWASA will provide wastewater services in the currently unserved areas noted as primary service areas. It also does not account for the proposed transfer of development rights program, the feasibility of which the County is currently reviewing.

Suggestions for Further Research

While this analysis has provided Orange County with some potentially valuable information for their upcoming long-range planning processes, it has also created several opportunities for related, further research. First, this project modeled just two scenarios, leaving a host of options for the county's future to be explored. Models could be designed to explicitly address a specific problem, such as affordable housing or rural character preservation. The impacts of these specific models on other pertinent problems could be assessed by comparing the results of each model. Further analysis could also be done with a village scenario similar to the one developed in this study, such as one that places the villages in different locations or experiments with different densities.

Second, a commercial build-out analysis would greatly complement this work. This could include both a build-out analysis for existing regulations as well as one that attempts to address economic development concerns or is linked to some of the issues described in this paper, such as affordable housing. Information on commercial development regulations would be needed not just from the zoning regulations, but also from the Economic Development Districts Design Manual as well as from the currently in progress small areas plans. These results, coupled with those of residential build-out analyses for different scenarios, would be a useful decision support tool for updates to any component of the Comprehensive Plan.

Third, a most complete analysis would find a means of including plans for Carolina North in the model. As described above, this project's location and amount of employment generated could have a very large impact on the surrounding areas in Orange County, affecting demand for housing, commercial services, and public services. Once the final plans have been adopted, an interested party could attempt to model its consequences for Orange County build-out and assess alternatives.

Finally, and perhaps most importantly, a valuable contribution related to the work done in this report would be an examination of cost of service provision and demand for public services for the different scenarios. Because varying densities and development patterns can have different fiscal impacts on public service provision, this is a topic that would likely be of great interest to stakeholders ranging from the Board of County Commissioners to taxpayers.

The results of this analysis provide something of a starting point for Orange County planners should they be interested in assessing alternative futures and choosing a growth management course of action most desirable to community members. It finds that given current regulatory conditions, the county population at build-out may be quite large. It also finds that strategically planning for growth can provide many benefits. By choosing where not to grow in tandem with accepting growth and consequently selecting areas for it to occur, the county can address two issues that are often diametrically opposed to one another. The concept of increasing densities in areas appropriate for development while decreasing densities in others appears poised to meet many demands of affordable housing advocates and environmentalists/rural aestheticists alike.

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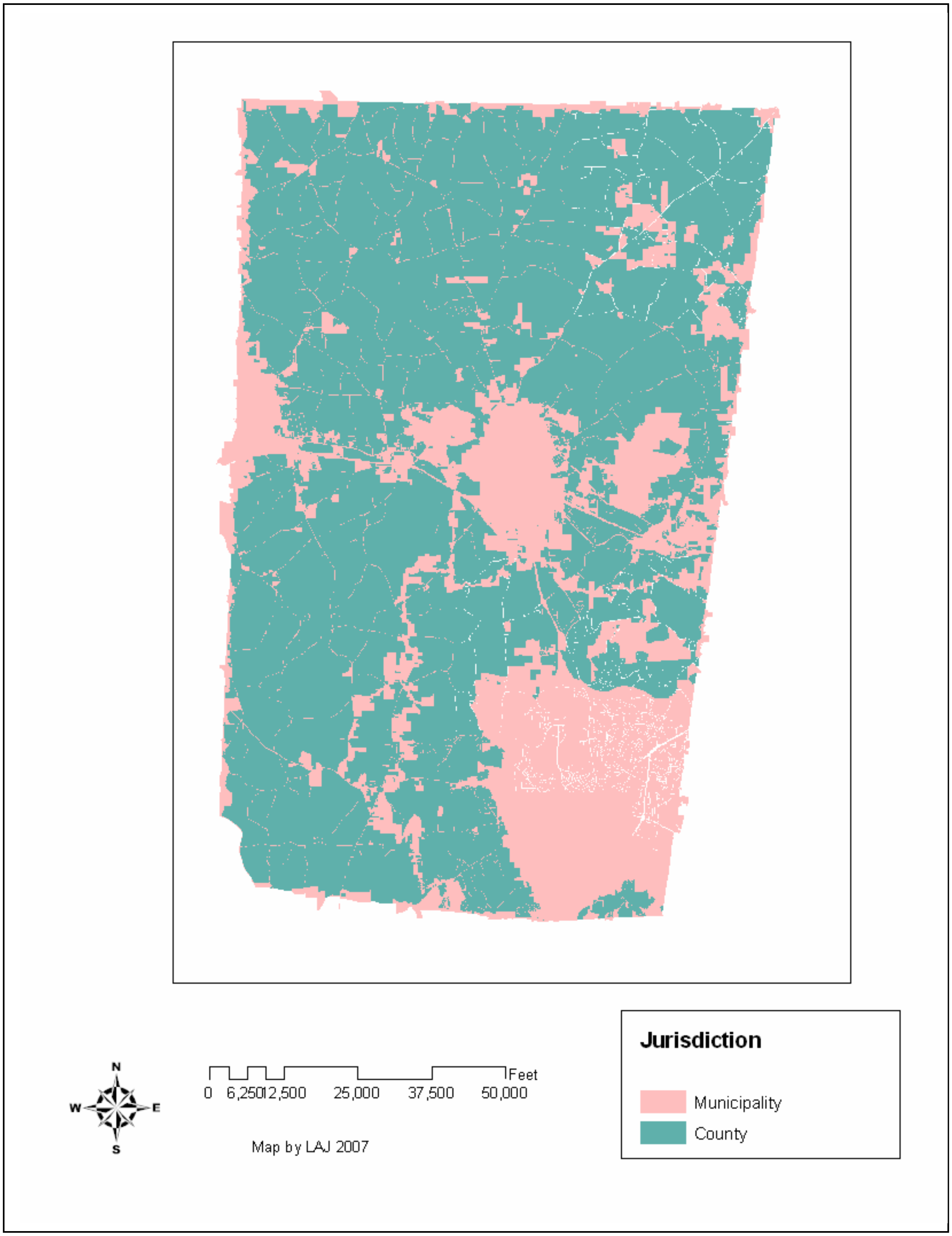
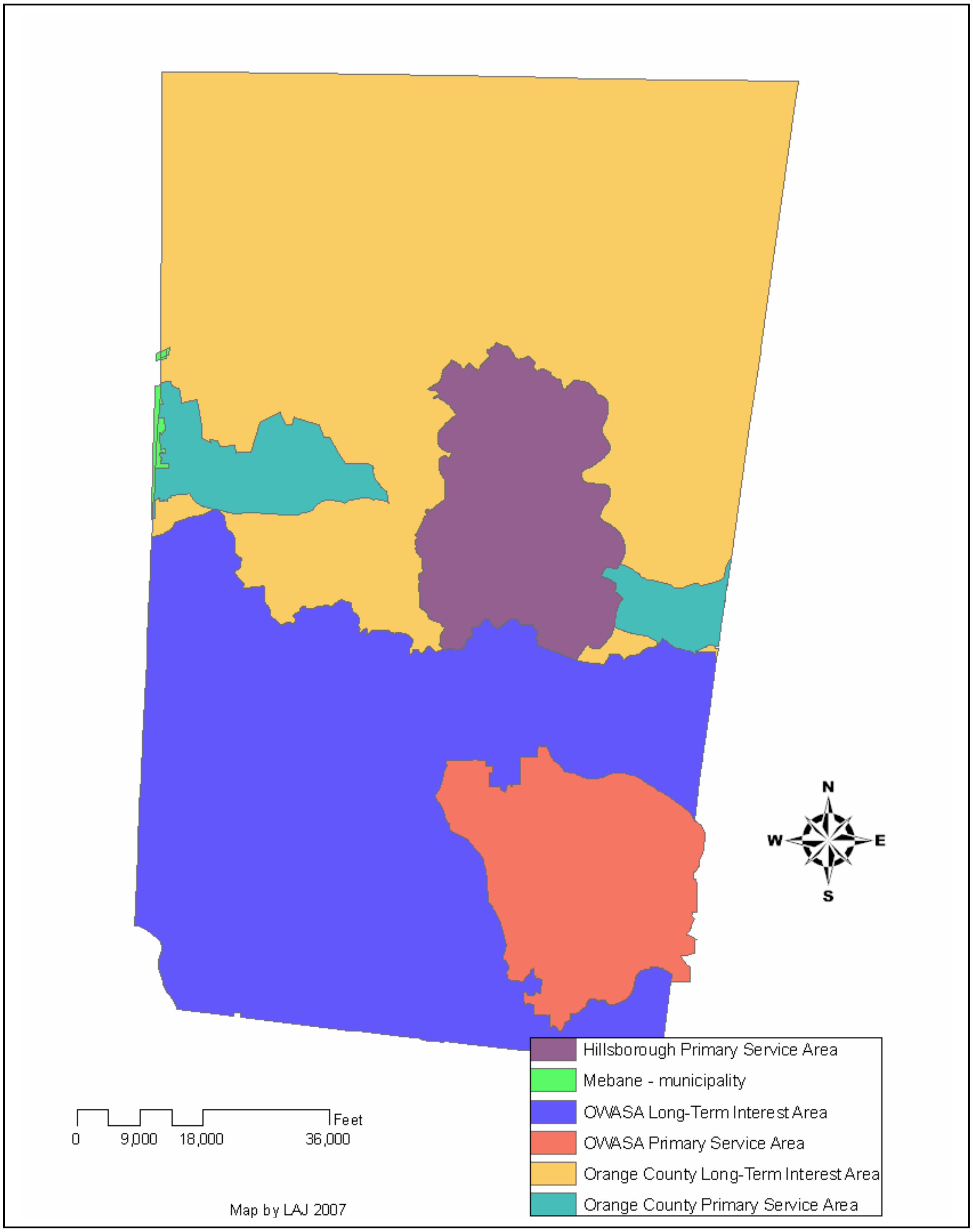
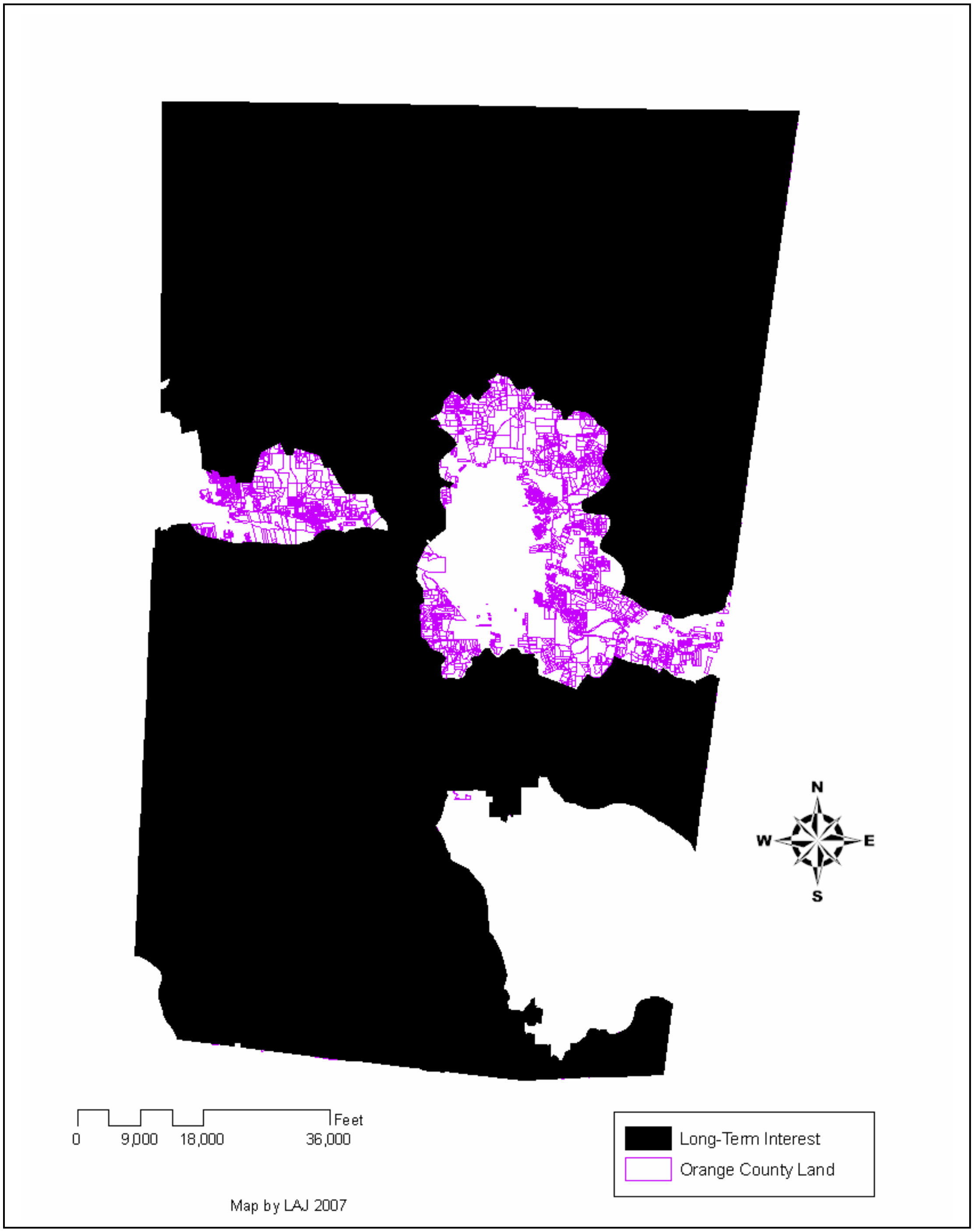
Appendix A: Orange County Zoning Jurisdiction



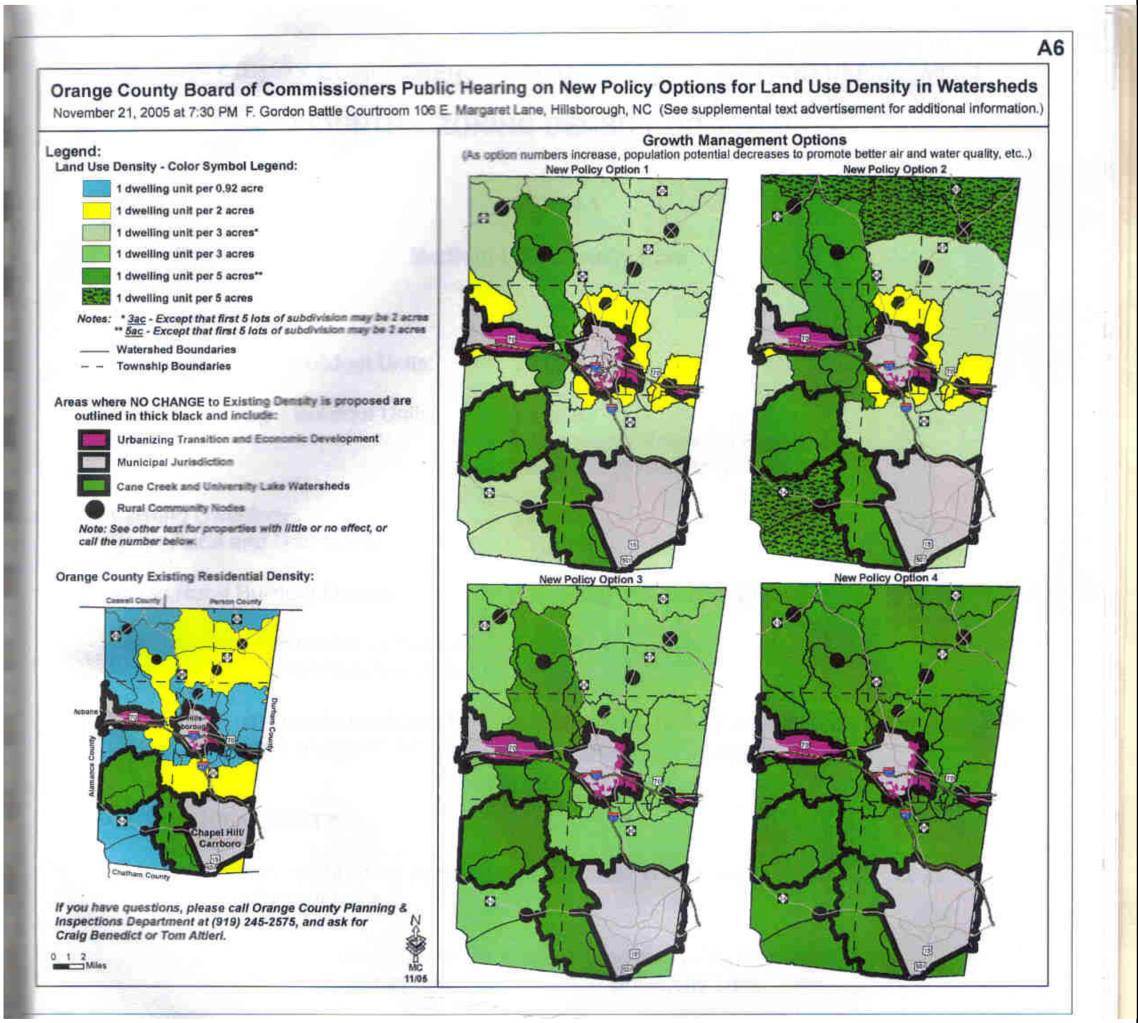
Appendix B: Wastewater Service Provision Boundaries



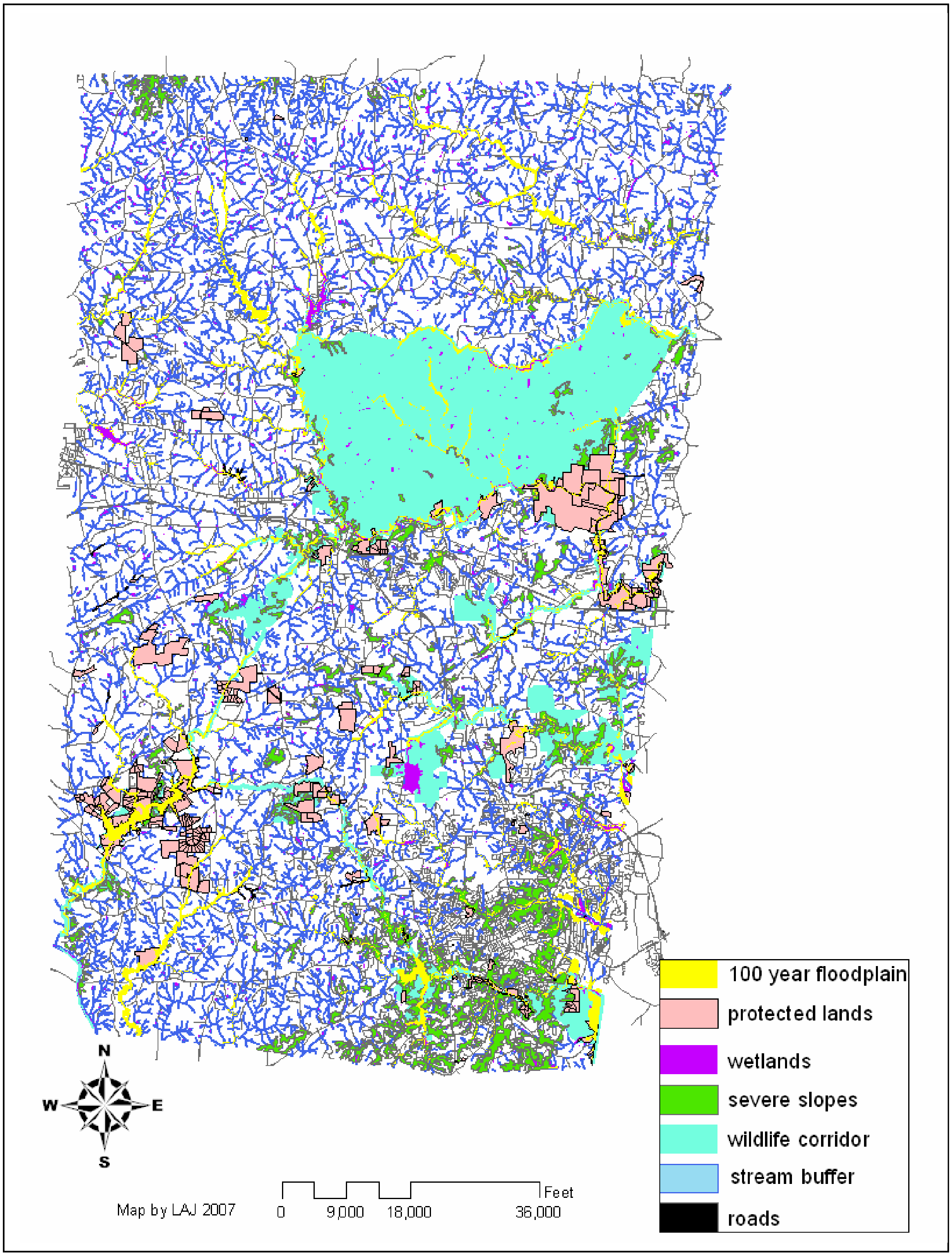
Appendix C: Wastewater Long-Term Interest Areas (i.e. those not expected to be provided with such services)



Appendix D: Orange County Proposed Policy Options for Land Use Densities in Watersheds (Draft Land Use Element o f 2006)



Appendix E: Constraints to Development



Build-Out Report - Base Scenario
Analysis Name: BASE
Sunday, April 01, 2007, 3:41 PM

Report Contents

Report Summary

This report gives details about a single run of the Build-Out Wizard for this scenario.

☑ Numeric Build-Out has been run

☑ Spatial Build-Out has been run

☒ Visual Build-Out has not been run

Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	OC land
Attribute specifying land-use designation	ZONING
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
AR	1.089 DU per acre		90
EC5	1.089 DU per acre		90
EDD			90
ED-LO-1			90
PD-1-73			90
PD-1-77			90
PDHR1			90
PDHR2			90
PDHR5			90
PID			90
R1	1.089 DU per acre		90
R2	2.174 DU per acre		90
R4	4.348 DU per acre		90
RB	0.5 DU per acre		90

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
AR	1	0	2
EC5	1	0	2
EDD	1	0	1
ED-LO-1	1	0	1
PD-1-73	1	0	1
PD-1-77	1	0	1
PDHR1	1	0	1
PDHR2	1	0	1
PDHR5	1	0	1
PID	1	0	1
R1	1	0	2
R2	1	0	2
R4	1	0	2
RB	1	0	2

Constraints to Development

Constraint Layer	Can density be transferred?
streets_10ft_buffer	no
severe_slope_new	no
100yrfloodplain	no
wildlife corridor	no
oc_capefear_nwi_poly - wetlands	no
oc_neuse_nwi_poly - wetlands	no
ce9_heldbyothers	no
con_easement906	no
permanently protected lands	no
penny_ce	no
streams_Buffer_65 feet	no

Existing Buildings

Layer containing existing buildings	Value or attribute specifying DU/bldg	Value or attribute specifying floor area (sq feet)
activeaddbldgjoin	1	AREA

Spatial Build-Out Settings

Settings				
Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
AR	20	Random		40
EC5	20	Random		40
EDD	0	Random		0
ED-LO-1	0	Random		0
PD-1-73	0	Random		0
PD-1-77	0	Random		0
PDHR1	0	Random		0
PDHR2	0	Random		0
PDHR5	0	Random		0
PID	0	Random		0
R1	20	Random		40
R2	15	Random		30
R4	10	Random		25
RB	20	Random		40

Results

Dwelling Unit Quantities				
Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
AR	79066	78958	108	7330
EC5	0	0	0	1
EDD	0	0	0	81
ED-LO-1	0	0	0	15
PD-1-73	0	0	0	1
PD-1-77	0	0	0	0
PDHR1	0	0	0	21
PDHR2	0	0	0	0
PDHR5	0	0	0	0
PID	0	0	0	0
R1	11299	11277	22	4109
R2	32	31	1	177
R4	8	8	0	45
RB	5625	5584	41	4272
Total	96030	95858	172	16052

Buildable Area

Land-Use Designation	Gross Area (sq feet)	Net Buildable Area (sq feet)	Difference (sq feet)
AR	5786162907.246	3963148201.305	1823014705.941
EC5	33945.709	33898.928	46.781
EDD	27064225.669	24325108.517	2739117.152
ED-LO-1	1820221.537	1534070.967	286150.569
PD-1-73	65456.369	37024.993	28431.376
PD-1-77	15421.464	15421.452	0.012
PDHR1	1289618.01	640497.648	649120.362
PDHR2	6353537.532	0	6353537.532
PDHR5	158548.924	0	158548.924
PID	8321483.419	0.385	8321483.034
R1	854383001.799	696584807.012	157798194.786
R2	4220043.57	3984108.878	235934.692
R4	680546.828	626871.396	53675.432
RB	1231085038.786	862879303.232	368205735.554
Total	7921653996.861	5553809314.714	2367844682.147

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space constraints	Number of commerical buildings that couldn't be placed because of space constraints	Number of polygons where number of existing buildings exceeds build-out limit
AR	108	108	0
EC5	0	0	0
EDD	0	0	0
ED-LO-1	0	0	0
PD-1-73	0	0	0
PD-1-77	0	0	0
PDHR1	0	0	0
PDHR2	0	0	0
PDHR5	0	0	0
PID	0	0	0
R1	22	22	0
R2	1	1	0
R4	0	0	0
RB	41	41	0
Total	172	172	0

Analysis powered by communityviz®

Appendix G: CommunityViz Report for Village Scenario

Build-Out Report - VILLAGE SCENARIO
Analysis Name: Village
Thursday, April 05, 2007, 2:44 AM

Report Summary

This report gives details about a single run of the Build-Out Wizard for this scenario.

☑Numeric Build-Out has been run

☑Spatial Build-Out has been run

☒Visual Build-Out has not been run

Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	villagewatershedjoin
Attribute specifying land-use designation	ZONING
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
1duper2acr	0.5 DU per acre		90
1duper3acr	0.33 DU per acre		90
1duper5acr	0.2 DU per acre		90
CLI			90
EC5			90
EDD			90
ED-LO-1			90
PD-1-73			90
PD-1-77			90
PDHR1			90
PDHR2			90
PDHR5			90
PID			90
R2	2.174 DU per acre		90
RB			90
R-WS	6 DU per acre		90
VMU1	12 DU per acre		90
VMU2	12 DU per acre		90
VMU3	12 DU per acre		90
VMU4	12 DU per acre		90

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
1duper2acr	1	0	2
1duper3acr	1	0	2
1duper5acr	1	0	2
CLI	1	0	1
EC5	1	0	2
EDD	1	0	1
ED-LO-1	1	0	1
PD-1-73	1	0	1
PD-1-77	1	0	1
PDHR1	1	0	1
PDHR2	1	0	1
PDHR5	1	0	1
PID	1	0	1
R2	1	0	2
RB	1	0	1
R-WS	1	0	2
VMU1	1	0	3
VMU2	1	0	3
VMU3	1	0	3
VMU4	1	0	3

Constraints to Development

Constraint Layer	Can density be transferred?
streets_10ft_buffer	no
severe_slope_new	no
100yrfloodplain	no
wildlife corridor	no
oc_capefear_nwi_poly - wetlands	no
oc_neuse_nwi_poly - wetlands	no
ce9_heldbyothers	no
con_easement906	no
permanently protected lands	no
penny_ce	no
streams_Buffer_65 feet	no

Existing Buildings		
Layer containing existing buildings	Value or attribute specifying DU/bldg	Value or attribute specifying floor area (sq feet)
activeaddbldgjoin	1	AREA

Spatial Build-Out Settings

Settings				
Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
1duper2acr	20	Random		40
1duper3acr	20	Random		40
1duper5acr	20	Random		40
CLI	0	Random		0
EC5	20	Random		40
EDD	0	Random		0
ED-LO-1	0	Random		0
PD-1-73	0	Random		0
PD-1-77	0	Random		0
PDHR1	0	Random		0
PDHR2	0	Random		0
PDHR5	0	Random		0
PID	0	Random		0
R2	15	Random		30
RB	0	Random		0
R-WS	10	Random		20
VMU1	8	Random		0
VMU2	8	Random		0
VMU3	8	Random		0
VMU4	8	Random		0

Results

Dwelling Unit Quantities

Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
1duper2acr	52	49	3	24
1duper3acr	3384	3349	35	3308
1duper5acr	12638	12513	125	10197
CLI	0	0	0	129
EC5	0	0	0	1
EDD	0	0	0	51
ED-LO-1	0	0	0	15
PD-1-73	0	0	0	1
PD-1-77	0	0	0	0
PDHR1	0	0	0	7
PDHR2	0	0	0	0
PDHR5	0	0	0	0
PID	0	0	0	0
R2	147	147	0	143
RB	0	0	0	0
R-WS	31545	31541	4	1487
VMU1	2470	2470	0	208
VMU2	2648	2648	0	115
VMU3	4949	4949	0	93
VMU4	5303	5303	0	290
Total	63136	62969	167	16069

Buildable Area

Land-Use Designation	Gross Area (sq feet)	Net Buildable Area (sq feet)	Difference (sq feet)
1duper2acr	150758026.288	7039930.204	143718096.084
1duper3acr	1277067692.604	776574633.485	500493059.119
1duper5acr	6017189807.569	4388492979.867	1628696827.702
CLI	37123812.516	33149189.28	3974623.236
EC5	33945.709	33898.928	46.781
EDD	5515566.855	4980561.563	535005.292
ED-LO-1	1820221.537	1534070.967	286150.569
PD-1-73	65456.369	37024.993	28431.376
PD-1-77	15421.464	15421.452	0.012
PDHR1	716303.471	111171.953	605131.518
PDHR2	6353537.532	0	6353537.532
PDHR5	158548.924	0	158548.924
PID	8321483.419	0.385	8321483.034
R2	13333826.362	6035784.596	7298041.765
RB	230206.602	159682.089	70524.514
R-WS	349089313.059	272754389.745	76334923.314
VMU1	12664355.798	11240707.935	1423647.862
VMU2	13167632.738	11344739.553	1822893.186
VMU3	22631789.681	20551964.448	2079825.233
VMU4	28022861.787	23018890.967	5003970.82
Total	7944279810.284	5557075042.411	2387204767.872

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space constraints	Number of commerical buildings that couldn't be placed because of space constraints	Number of polygons where number of existing buildings exceeds build-out limit
1duper2acr	3	3	0
1duper3acr	35	35	0
1duper5acr	125	125	0
CLI	0	0	0
EC5	0	0	0
EDD	0	0	0
ED-LO-1	0	0	0
PD-1-73	0	0	0
PD-1-77	0	0	0
PDHR1	0	0	0
PDHR2	0	0	0
PDHR5	0	0	0

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1duper2acr	3	3	0
1duper3acr	35	35	0
1duper5acr	125	125	0
CLI	0	0	0
EC5	0	0	0
EDD	0	0	0
ED-LO-1	0	0	0
PD-1-73	0	0	0
PD-1-77	0	0	0
PDHR1	0	0	0
PDHR2	0	0	0
PDHR5	0	0	0
PID	0	0	0
R2	0	0	0
RB	0	0	0
R-WS	4	4	0
VMU1	0	0	0
VMU2	0	0	0
VMU3	0	0	0
VMU4	0	0	0
Total	167	167	0

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